UNIVERSITI PUTRA MALAYSIA

GROWTH PERFORMANCE OF HILL DIPTEROCARP FORESTS FIVE YEARS AFTER HARVESTING AT THE ANGSI FOREST RESERVE, NEGERI SEMBILAN, MALAYSIA, 2007

FRISCO NOBILLY.

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By

FRISCO BIN NOBILLY

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

April 2007

TO MY LOVELY MOTHER,
MADAM TERISAH @ UNGA SIPAI SIAU

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Associate Professor Awang Noor Abd. Ghani, PhD

Faculty: Forestry

The future long-term timber supply from sustainably managed forest in Peninsular Malaysia is largely dependent on the availability of timber from the productive Permanent Forest Estate (PFE) especially from the Hill Dipterocarp Forests. Future log supply also will come from the second and successive harvest in logged-over forest. Specific information on behaviours of particular forest stand pertaining to growth performance, mortality, density, structure and species composition is required to evaluate the management systems and its suitability under different forests types.

The study was conducted in a logged over Hill Dipterocarps Forest in Angsi Forest Reserve, Negeri Sembilan with the objective to evaluate the growth response five years after harvesting. The data consist of five annual measurements (2000-05) collected from four 1-ha permanent sample plots.

The data were analysed in terms of diameter increments, basal areas, tree volumes and also growth projection using existing growth and yield model.

The results show pattern and trend of tree growth five years after logging. The stocking of trees, basal area and volume for both trees over 5 and 30 cm dbh were significantly different ($p<0.05$) among plots, species groups and measurement years. The ANOVA also showed that the interaction between species groups, study plots and measurement years were also significant ($p<0.05$).

Stocking of trees for both over 5 and 30 cm dbh showed an increment over the measurement period. However, the overall increment rates of all trees over 30 cm dbh were relatively low, when compared to the rates assumed under the Selective Management System (SMS). The overall diameter periodic annual increment (DPAI) of 0.65 cm $tree^{-1}$ yr^{-1} for all trees over 30 cm dbh is considerably lower than the rate of 0.8 to 1.0 cm $tree^{-1}$ yr^{-1} assumed under the SMS. Although the DPAI of the dipterocarps was higher than the non-dipterocarps, their overall contributions to forest growth was small due to their lower stocking in the residual stand. The overall mean annual mortality (3.51%) of all trees over 30 cm dbh for 5-year period was higher than that assumed under the SMS (0.9%). Based on these growth rates, anticipating a second cut in 25 to 30 years as stipulated under SMS, would not be applicable for this area. Therefore, future research on behaviour of the forest should be conducted.

Based on projection of growth and yield model until year 60 indicates that growth in timber, basal area and the number of stems per hectare is increasing each period until end of the projection period (year 60) at slower state. This shows that the study areas will experience long growth period due to high density of trees in lower diameter class.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

PRESTASI PERTUMBUHAN HUTAN DIPTEROKARPA BUKIT LIMA TAHUN SELEPAS PENUAIAN DI HUTAN SIMPAN ANGSI, NEGERI SEMBILAN, MALAYSIA

Oleh

FRISCO BIN NOBILLY

April 2007

Pengerusi: Profesor Madya Awang Noor Abd. Ghani, PhD

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Bekalan kayu daripada hutan terurus secara berkekalan pada masa hadapan adalah bergantung sepenuhnya kepada keterdapatan kayu dari Hutan Simpanan Kekal (HSK) yang produktif, terutamanya dari Hutan Dipterokarpa Bukit. Oleh kerana hutan dara hanya tinggal sedikit yang tinggal, penghasilan kayu balak pada masa hadapan bergantung kepada kelas dua atau dirian tinggal hutan terpulih yang telah dibalak. Oleh yang demikian, pengetahuan yang spesifik berkenaan kelakuan hutan dari segi prestasi pertumbuhan, kematian, kepadatan, struktur serta komposisi spesis adalah sangat diperlukan untuk mengukur system pengurusan serta kesesuaiannya pada jenis kawasan hutan yang berbeza.

Kajian ini telah dijalankan di Hutan Dipterokarpa Bukit yang telah dibalak yang terletak di Hutan Simpan Angsi, Negeri Sembilan dengan objektif untuk menilai tindakbalas pertumbuhan pokok selepas pembalakan lima tahun. Data merangkumi 5 tahun pengukuran (2000-2005) daripada empat sampel

plot bersaiz 1 hektar. Data-data ini kemudianya dianalisa berdasarkan pertumbuhan diameter, luas pangkal, isipadu pokok serta sorotan pertumbuhan dengan menggunakan model pertumbuhan dan hasil sedia ada.

Keputusan menunjukkan menunjukkan perubahan pertumbuhan selama 5 tahun selepas dibalak. Jumlah bekalan bilangan pokok, luas pangkal serta isipadu kasar bagi pokok yang melebihi 5 serta 30 sm dpd mempunyai perbezaan bererti ($p<0.05$) diantara sampel plot, kumpulan spesis dan tahun pengukuran. Keputusan terhadap ANOVA menunjukkan interaksi diantara kumpulan spesis, sampel plot serta tahun pengukuran juga mempunyai perbezaan bererti ($p<0.05$).

Bekalan pokok melebihi 5 serta 30 sm dpd menunjukkan peningkatan sepanjang tahun pengukuran. Walau bagaimanapun, kadar pertumbuhan keseluruhan bagi semua pokok melebihi 30 sm dpd adalah rendah berbanding dengan kadar pertumbuhan yang diandaikan berdasarkan Sistem Pengurusan Memilih (SPM). Pertambahan diameter tahunan dari masa ke semasa untuk keseluruhan pokok adalah 0.65 sm pokok^{-1} tahun^{-1} untuk semua pokok melebihi 30 sm dpd didapati rendah berbanding dengan kadar 0.8 hingga 1.0 sm pokok^{-1} tahun^{-1} seperti tercatit dalam SPM. Walaupun pertambahan diameter tahunan dari masa kesemasa bagi kaum dipterokarp adalah tinggi daripada kaum bukan dipterokarp, sumbangan keseluruhannya terhadap pertumbuhan dirian hutan tinggal adalah rendah kerana bilangannya yang kurang. Purata tahunan kematian sepanjang 5-tahun pengukuran adalah sebanyak 3.51 % lebih tinggi jika dibandingkan dengan 0.9% seperti

yang tercatat pada SPM. Berdasarkan kadar pertumbuhan ini, kelayakkan untuk pusingan tebangan kedua pada tahun ke 25 hingga tahun 30 seperti yang dicatatkan dalam SPM tidak dapat diaplikasikan untuk kawasan hutan ini. Oleh yang demikian, adalah sangat deperlukan untuk menjalankan kajian serupa ini pada masa akan datang.

Berdasarkan soroton model pertumbuhan dan hasil sehinggalah ke 60-tahun, menunjukkan peningkatan pertumbuhan isipadu kayu, luas pangkal, bilangan pokok per hektar pada setiap tempoh sorortan sehinggalah ke sorotan yang terakhir (60 tahun) pada kadar yang perlahan. Ini menunjukkan, kawasan kajian ini akan mengalami pertumbuhan pokok bersaiz kayu jaras dalam tempoh masa yang panjang dengan regenerasi pokok yang bersesuaian.

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I would like to thank my colleagues in somehow have helped me to finish up my studies (Dr. Pakhriazad Hassan Zaki, Dr. Kamziah Abd. Kudus, Mr. Sapari Mat and Mr. Affendi Suhaili). To my parent, brothers and sisters and also my beloved friends that around me, who have shared all the happiness and disappointments during my study period, I wish to express my sincerest thanks and love.

I certify that an Examination Committee has met on 30th April 2007 to conduct the final examination of Frisco bin Nobilly on his Master of Science thesis entitled "Growth Performance of Hill Dipterocarp Forests Five Years After Harvesting at the Angsi Forest Reserve, Negeri Sembilan, Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the degree of Master of Science.

Members of the Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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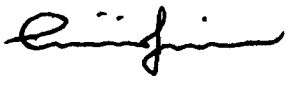

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Date: 9 AUGUST 2007

DECLARATION

I declare that the thesis is my original work except for the quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

FRISCO BIN NOBILLY

Date: 1 AUGUST 2007

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LIST OF ABBREVIATIONS

AIFM	ASEAN Institute of Forest Management
dbh	diameter at breast height (cm)
DIPSIM	Dipterocarp Forest Growth Simulation Model
FAO	Food and Agriculture Organization
FORSTAM	Forest Stand Management Model
FORTRAN	Forest Stand Projection Model
GYMMTF	Growth & Yield Model for Mixed-Tropical Forests In Peninsular Malaysia
MUS	Modified Malayan Uniform System (MUS).
SMS	Selective Forest Management System
STANPRO	Stand Table Projection Model

CHAPTER 1

INTRODUCTION

1.1 General Background

The forest ecosystems of Malaysia are classified into several schemes which vary according to substrate (i.e. dry or wet soil types), floristic composition, altitude and other features. Examples of widely used forest classification systems applicable to Peninsular Malaysia are given by Symington (1943), Wyatt-Smith (1963) and Whitmore (1990). Ashton (1995) compares forest profiles in Sabah and Sarawak to those in Peninsular Malaysia.

The dipterocarp forests is one of others forest types that are of vital economic and ecological importance of Peninsular Malaysia. In 2005, they constituted about 5.40 million hectares or 44.70 % of the total forested area of Peninsular Malaysia (MTC, 2006) and formed the bulk of the production forest of the permanent forest reserve. They comprise the well-drained forests of the plains, undulating land foothills up to an elevation of 1,300 m a.s.l.

The dipterocarps forest can be classified as Lowland Dipterocarp, Hill Dipterocarp and Upper Dipterocarp Forests, according to the classification of Wyatt-Smith (1963). Lowland Dipterocarp Forest occurs up to an elevation of 300m. Together with hill dipterocarp forest, it constitutes the main forest type in Malaysia. Primary lowland dipterocarp forest consists of dominant and co-dominant strata reaching 45m in height with emergent trees reaching 60m in

height. An intermediate stratum of trees forms a canopy between 23m and 30m, below which grows suppressed vegetation. Where emergent trees are rare, the forest forms a three-layered stand. Ground vegetation is of moderate density. About half of the upper-story trees belong to the Dipterocarpaceae family. In Sarawak, no distinction is made between lowland and hill dipterocarp forests. They are generally referred to as mixed dipterocarp forest, and occupy an area from the inland limit of the freshwater peat swamps to the lower limit of the montane forests. In Sabah, lowland dipterocarp forest is further divided into sub-types based on species dominance, such as *Parashorea malaanonan* forest and *Shorea/Eusideroxylon zwageri* forest.

Hill Dipterocarp Forest occurs between elevations of 300 m and 1300 m a.s.l. Many of the lowland dipterocarp forest genera are represented but species composition varies. Ridges, for example, are often dominated by *Shorea curtisii* (Seraya forest), and non-dipterocarp species such as *Swintonia spicifera* occur frequently. Hill forests are found on ultisols, oxisols and podzols with low agricultural potential. They currently form the bulk of the productive permanent forest estate. In Sabah, two sub-types of hill dipterocarp forest are distinguished: i) *Shorea* forest (Selangan Batu forest) found on steeper and higher hills; and ii) *Dipterocarpus/Shorea* forest on sandstone escarpments along the east and north coast.

Upper Dipterocarp Forest or montane forest occurs above 1300 m a.s.l. on brown earth and podzol soils. In Peninsular Malaysia this forest type contains few dipterocarp species. Commonly found species belong to the Fagaceae

(*Quercus*, *Lithocarpus* and *Castanopsis* spp.) and Lauraceae families. Other species include *Agathis alba*, *Engelhardtia* spp. and *Podocarpus* spp. Ericaceous ('mossy') forests with few oaks occur above 1600m in the cloud belt. *Pteris ovalifolia, Rhododendron* spp. and *Vaccinium* spp. are common on acid peaty gley soils. In Sabah, montane dipterocarp forests occur above the zone of hill dipterocarp forests in the Crocker Range and the central uplands. The main species here are *Shorea platyclados*, *Shorea venulosa* (on ultra basic rocks), *Shorea monticola*, *Shorea laevis*, *Hopea montana*, *Hopea dyeri, Dipterocarpus ochraceus*, *Vatica dulitentis*, and *Vatica umbonata*. At higher elevations these forests become oak-chestnut forests and, at elevations over 2000m, they are replaced by mossy forests rich in conifers and Ericaceae.

Despite their economic importance, the dipterocarp forests have been greatly depleted particularly, the Lowland Dipterocarp Forest. This has been due to the large-scale agricultural development through the conversion of forested land to agriculture, mainly rubber and oil palm plantations, under the various Malaysian National Development Plans since 1961. It was estimated some 2 million hectares or 15 % of the total forested area of Peninsular Malaysia, were converted to agriculture crop over the period from 1960 to 1978 (Harun, 1981). The massive land conversion was based on the Land Capacity Classification (LCC) which has been used as the basis for land use planning in Malaysia since 1964. Under the LCC, land suitable for mining (minerals) and agriculture are given development priority over forestry. Hence, only those areas that have no potential for mining and agriculture were relegated for long-term forestry use.

The fast depletion of the dipterocarp forests was also confirmed by the First National Forest Inventory of Peninsular Malaysia, which was conducted from 1970 to 1972. The results of the inventory indicated that virtually all easily accessible lowland and foothill forests had been logged. About one-third (the more accessible) of hill forest reserves had been exploited, while the remaining forests were found on steeper slopes in the remote parts of the country (FAO, 1973).

1.2 Problem Statement

In Peninsular Malaysia, the production forests of the PFE are managed under two management systems, the Malayan Uniform System or MUS (based on a 55-year cutting cycle), and the Selective Management System or SMS (based on a 30-year cutting cycle). Under the MUS, all mature commercial trees above 45cm diameter at breast height (dbh) are harvested in one operation in the area being logged (Wyatt-Smith, 1963; Thang, 1988). Under the SMS, management (felling) regimes are determined using pre-felling inventory data (Thang, 1987; Thang, 1988).

Following logging under the MUS, all remaining large trees of non-commercial species are removed by poison girdling. The next tree crop develops from seedlings and consequently is of uniform age. According to Wyatt-Smith (1988), the MUS is not environmentally degrading, although it is not oriented towards gene conservation.

As the MUS relies primarily on seedlings and saplings to establish succeeding crops, silvicultural treatments are designed to favour these groups, often at the expense of larger trees. This bias tends to encourage more poison girdling than is necessary and, in some cases, excessive opening of the canopy. Over time, however, the emphasis of management has moved from seedlings and saplings to the remaining large trees. This has reduced the incidence of poison girdling and has promoted a more conservation-oriented approach to silvicultural treatments (Hashim, 1997).

The depletion of the lowland forests in Peninsular Malaysia has initiated the beginning of a new era of forestry, which is the management of hill forests. The introduction of various mechanized logging methods has to a great extent been a catalyst for further development of hill timber harvesting. After modification, the MUS has been applied successfully in lowland dipterocarp forests. It is unsuitable for hill dipterocarp forests, however, owing to the more difficult terrain, uneven stocking, a lack of natural regeneration, erosion risks on steep slopes and the secondary growth promoted by canopy opening. It's even raised some concerns on the suitability of the management or silvicultural system as the system that was devised for the lowland forests was clearly unsuitable.

These and other factors have resulted in a growing support for a selective harvesting system in Peninsular Malaysia (Tang and Wan Razali, 1981). Consequently, in 1978, the SMS was introduced for hill forests. This system is